The WIYN One Degree Imager
January 2009

Daniel Harbeck, Project Scientist
for the ODI Team

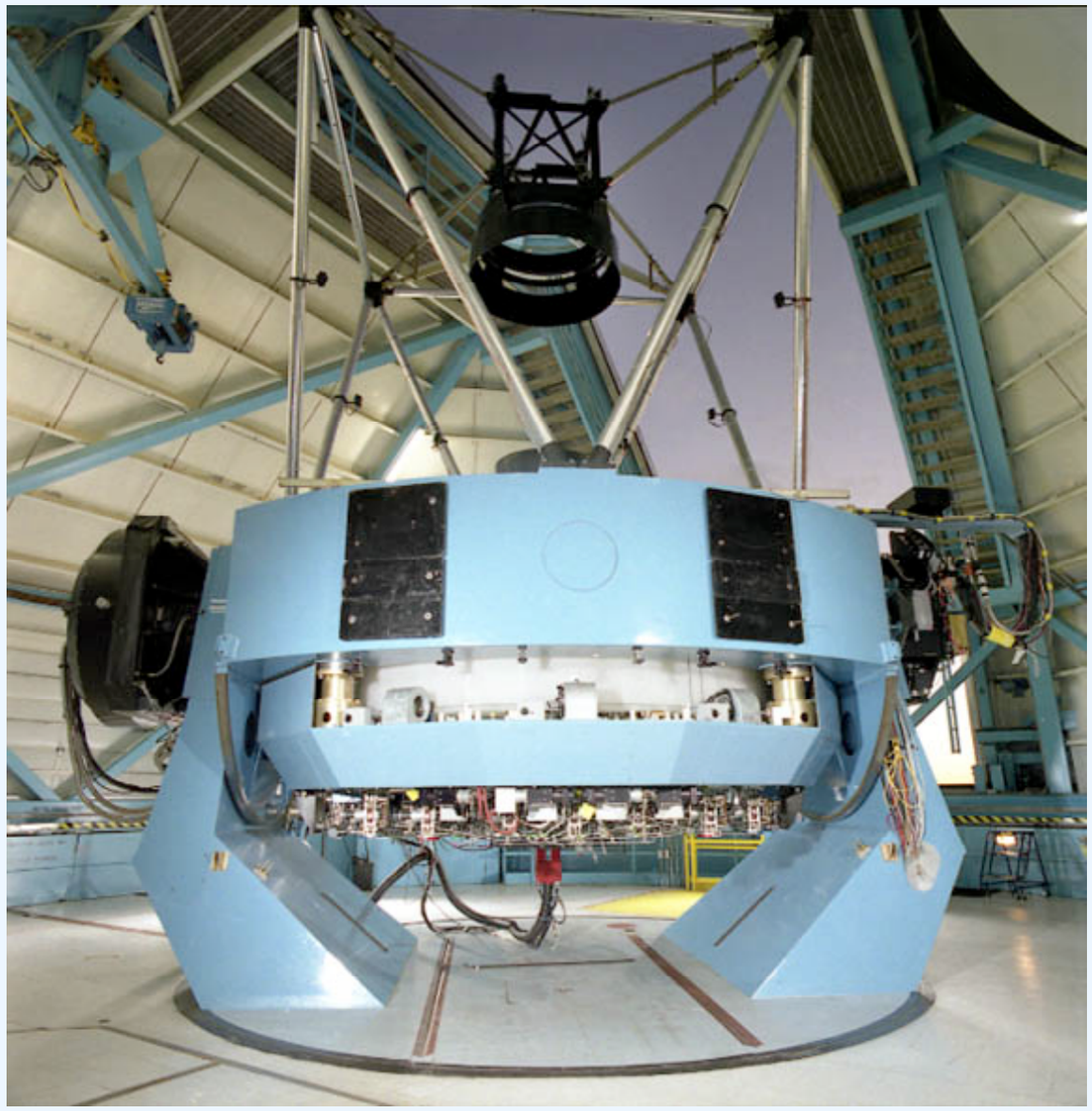
View from the 4 meter telescope

- WIYN Consortium, telescope built in 1995:
  - University of **W**isconsin, Madison (26%)
  - **I**ndiana University , Bloomington (17%),
  - **Y**ale, New Haven (17%)
  - **N**ational Optical Astronomy Observatory (40%)

WIYN: A modern telescope

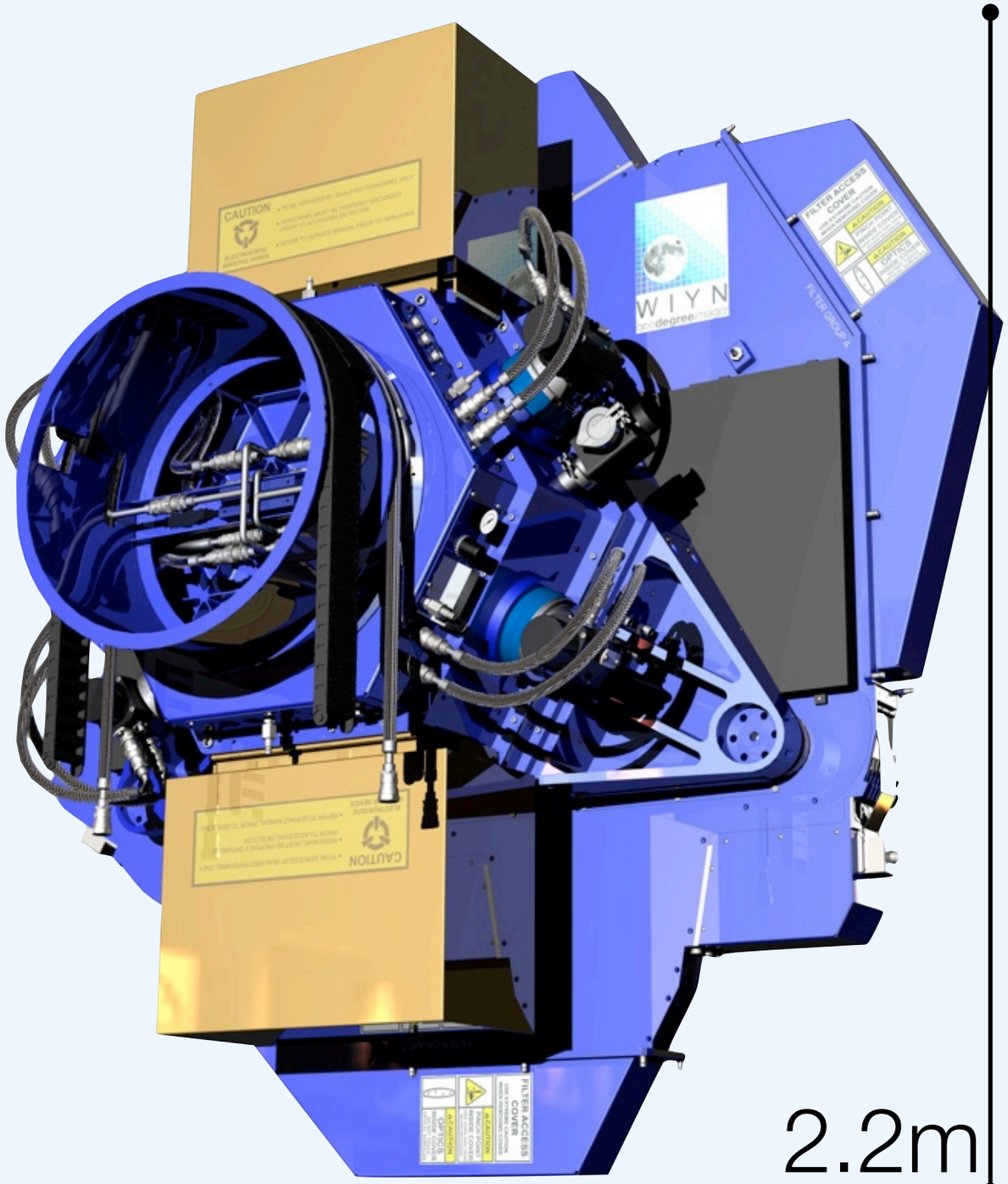
- Optimized for image quality:
  - active primary mirror support.
  - careful thermal design.
  - excellent optics.
  - excellent site.

- 1° circular unvignetted field of view
  DIQ is atmosphere limited.
  - seeing of 0.35” on science exposures reported.
  - Median seeing in R better than 0.7”.



WIYN One Degree Imager (ODI)

- 1º Field of View, 8x8 CCD Detector Array.
- 1 Billion Pixels, 0.11” on sky per pixel.
- <10 seconds readout time.
- 64 CPU-core data acquisition cluster.
- Active Image Motion Compensation with novel CCD detectors.
  - **O**rthogonal **T**ransfer **A**rray CCD, same technology as in PanSTARRS.
- General facility instrument.
- Installation & first light in spring 2010.



Key Science cases

- Solar system objects.
- Stellar physics, properties of star clusters.
- Galactic structure, galaxy halos in the Local Group.
- Interstellar medium in the Local Universe (narrow-band imaging).
- Galaxy evolution.
- Supernovae.
- Weak & Strong lensing.
- **Wide field, high resolution imaging.**

- Enable PI science.
- Enable institution-wide surveys (e.g., Yale, 90+ nights survey, LSST cadence).

Orthogonal Transfer Array CCDs

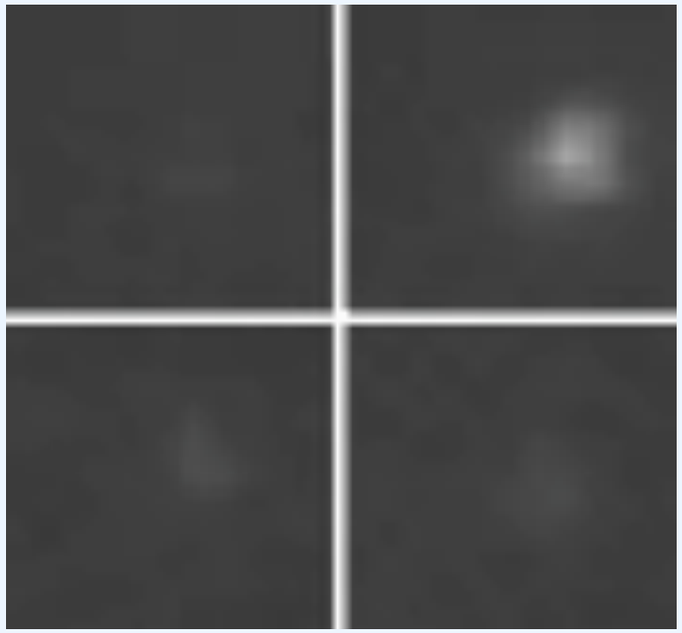
Image motion compensation over a 1° field of view.

Effect of Tip/Tilt motion on image quality

- Atmospheric turbulence, wind-shake cause image motion. Degrades image quality.

- Some image motion is correlated, e.g., due to telescope shake.

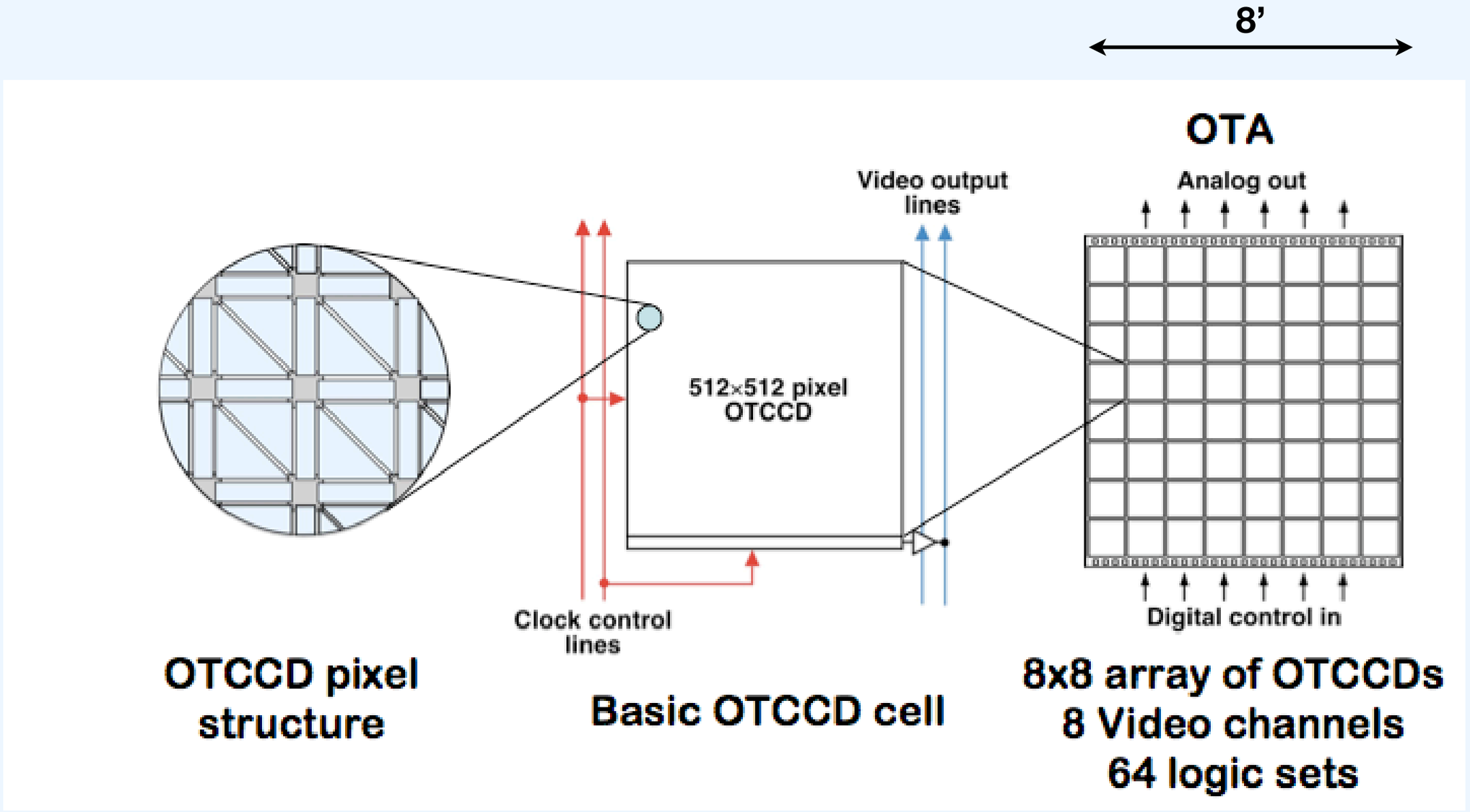
- Uncorrelated image motion due to atmospheric turbulence.



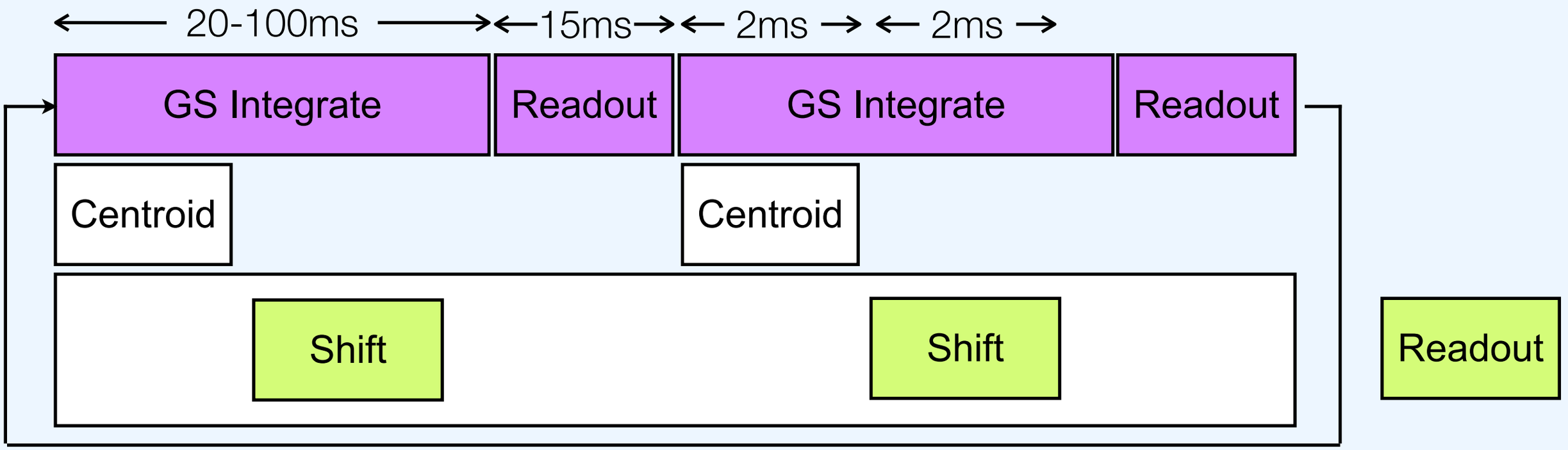
- Idea: sense motion from a bright guide star and compensate for it:
  - Active secondary mirror (common in AO systems).
  - Move detector (consumer digital cameras).
  - Move electrons in detector (Orthogonal Transfer CCD).

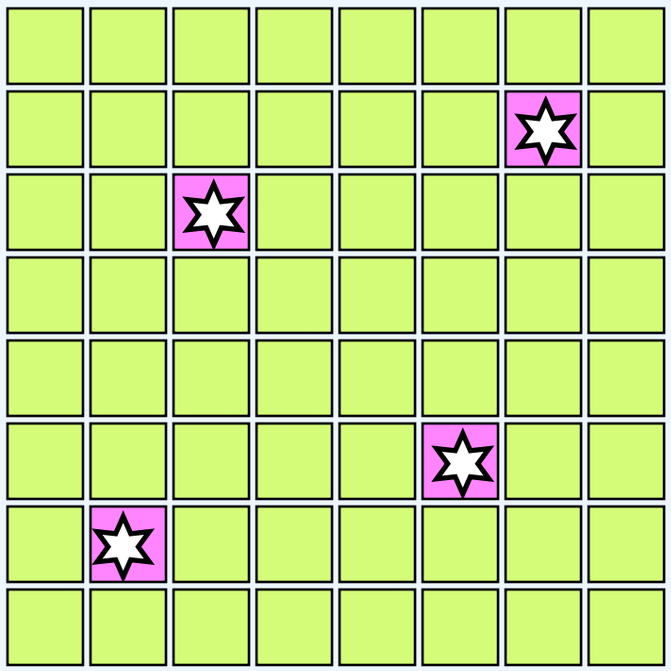
- **New Idea: do it over 1° FoV**

Orthogonal Transfer Array Detector



OTA fast tip/tilt guiding





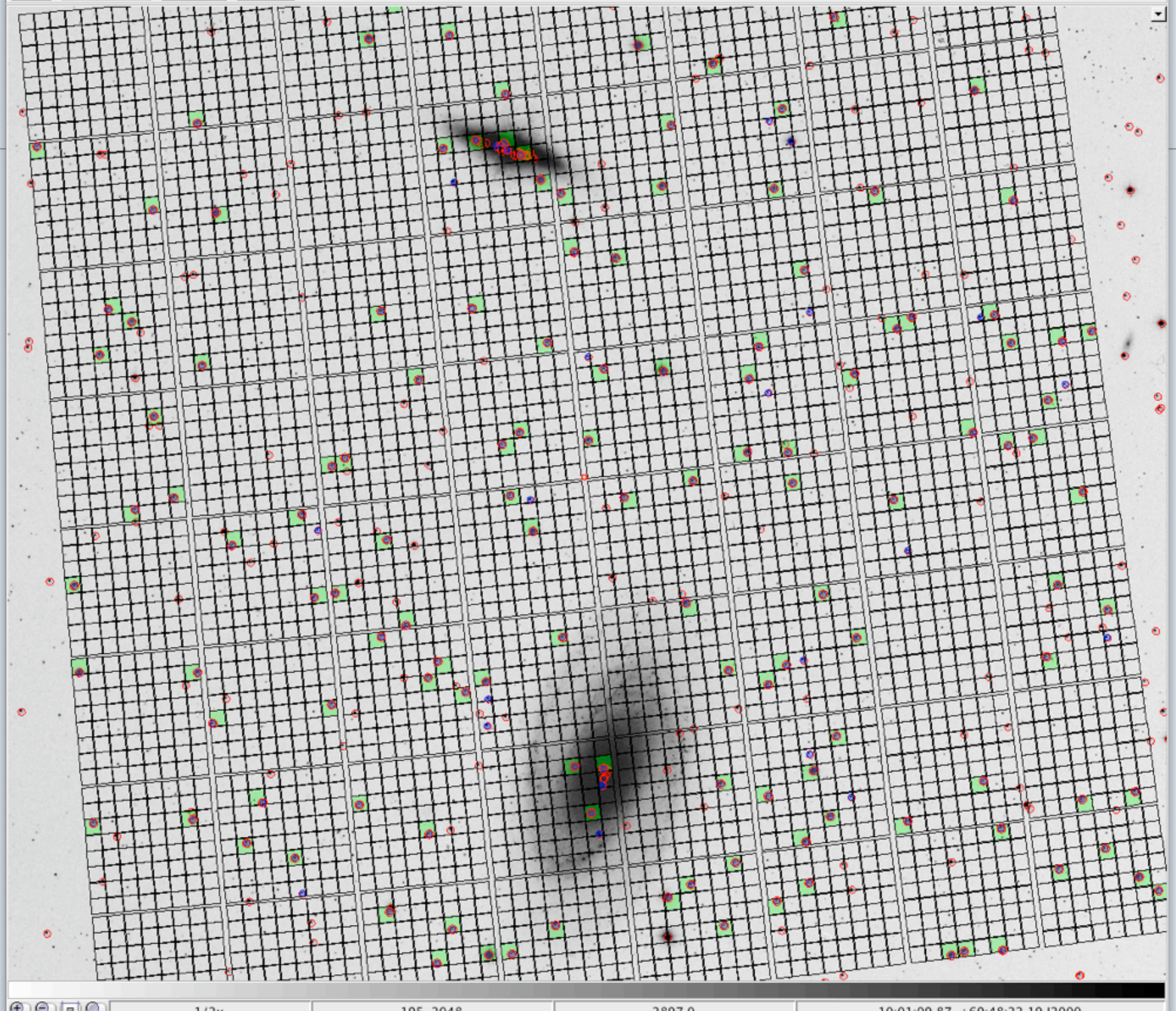
Weight of guide star *i* on cell *j*:

$$\delta\vec{x}_j = \frac{\sum {r_{ij}}^{-n} \cdot \delta\vec{x}_i}{\sum {r_{ij}}^{-n}}$$

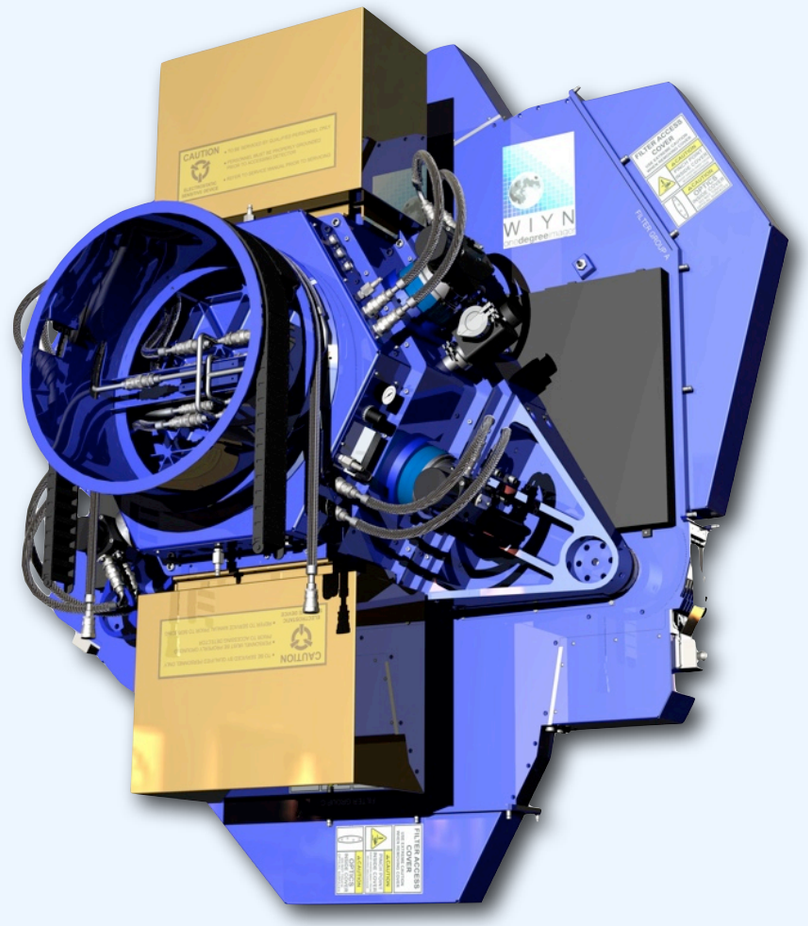
n=0	equal weight, common mode only
n=1..2	distance weighted
n=large	nearest neighbour

File View Go Graphics Catalog ODI Phase II

Open Back Forward Cut Levels Catalogs



1/2x 195, 2048 2897.0 10:01:09.87, +69:48:22.19 J2000



Hardware Status

ODI Assembly Started in Tucson

Instrument Support Package & Filter Swing Arm

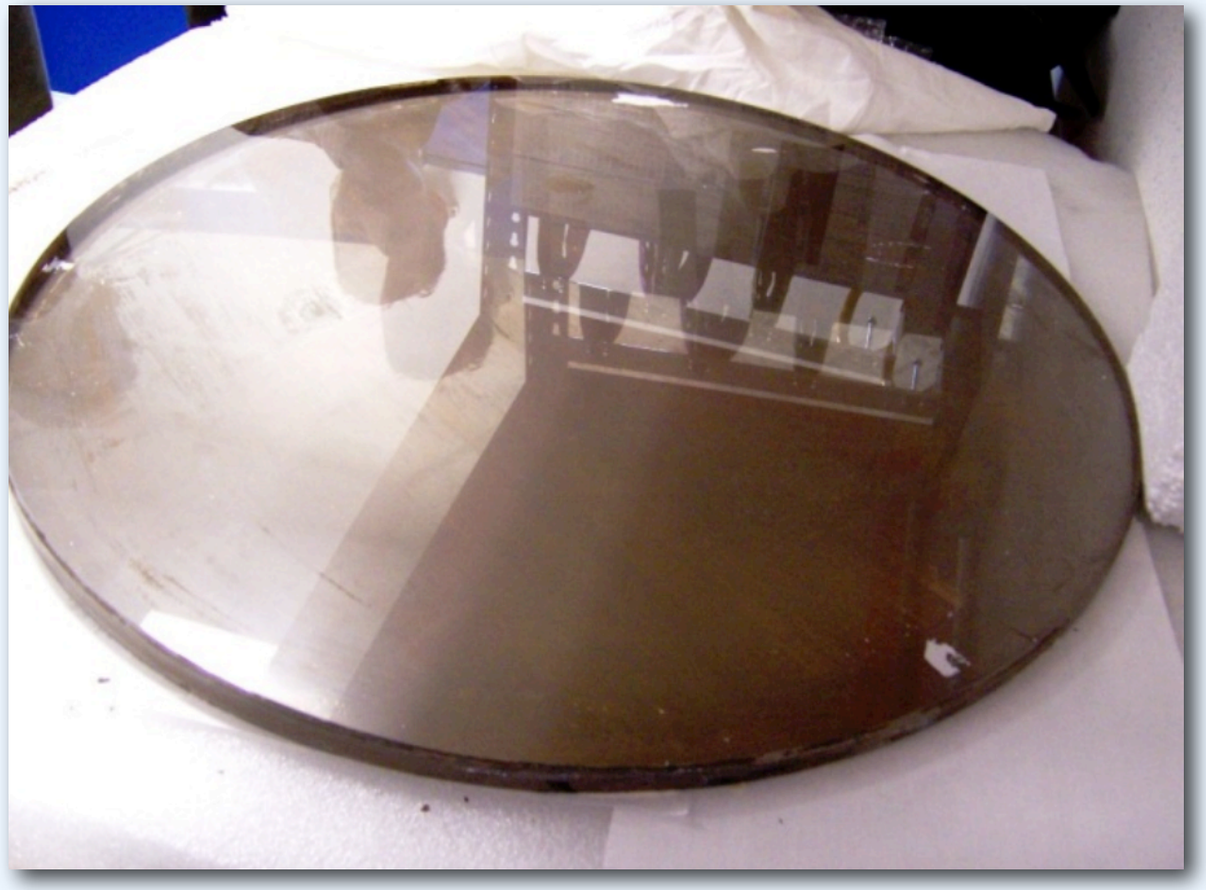
- Large parts finished up to Dewar lens interface.
- ADC mechanism mounted
- Filter swing arms mounted
- Telescope port interface cart
  - Allows rotating the instrument

Bonn Shutter

- Fabrication complete @Bonn/Hoher List
- Testing started.
- Delivery February 2009.
- RS232 interface for control, TTL trigger.

Optics

- Slightly delayed delivery of **lenses** schedule (2 months)
  - PBL6Y prisms - January
  - Fused Silica prisms - January
  - Lens #2 - February
  - Lens #1 - February
  - Our test of test optics passed!



- **Anti-Reflection Coatings** Contract
  - Awarded to Infinite Optics, CA
  - Delivery within 2 month of receipts
  - of optics

Focal Plate

- Base plate to mount detectors.
  - Made of Silicon Carbide Ceramics
  - Flat to within 10μm!
  - Superb thermal properties.
  - Mechanically like glass.

- We have two of them
  - some machining required.

ODI Filters

- Last remaining major contract for ODI
  - First filters (SDSS g’ r’ i’) on order.
  - Joint order with PanSTARRS.
- Next order in preparation:
  - u’-band filter, specifications TBD.
  - $H\alpha$, O[III], bandpass definition in prep.
  - Potentially mosaiced design.

Insert Picture of Filter here.
- once arrived -

ODI Assembly and Integration Time Line

2009

Summer Shutdown

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

ISP Assembly

ADC Bonding

ISP Lab Test

ISP@WIYN → ISP to remain at KPNO (?)

Dewar Window Assembly to Tucson

Dewar Shell Assembly & Thermal Testing

Shell Complete

Delivery of populated focal plane

Lot 4 & Stargrasp Dewar & Test Stand

Focal Plane Testing

2010

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Cntd.

All WIYN facility upgrades to be finalized and checked out

ODI Installation

ODI Commissioning

... ODI Commissioning continued

ODI Instrument Pipeline

- **Instrument pipeline:** Overscan, bias, cross-talk, flat field (OTA-specific), World Coordinate System to 0.2”.

- Finished by ~12 pm after observing night (visitor mode!). Potentially response time < 2 minutes.

- Master calibration files created at afternoon:
  - Dome flats, bias.
  - Super sky flat from WIYN repository.

- Shortcoming:
  - No master calibration files from actual science data!
  - Some reprocessing required after observing runs.
  - Pipeline operations might be overwhelming for observer.

ODI Pipe Dreams

- **Tier 0**
  Quick look analysis for observers and time-domain programs: very basic analysis done on site on local machines.

  ODI Instrument Project

- **Tier 1**
  End-of-run, removal of instrument signatures and crude spectrometric and photometric calibrations on individual images. Updated master calibration products.

  Expanded Operations

- **Tier 2**
  Image stacking, high-accuracy astrometric and photometric solutions, psf re-sampling, cosmic ray removal, fringing correction.

- **Tier 3**
  Fine-tuning on stacking (e.g specific selections of images) and production of catalogs.

  Expanded Operations.

Tier 1-3 Implementation

- In project definition phase.

- Use parts of PanSTARRS **I**mage **P**rocessing **P**ipeline for ODI:
  - Designed to be distributable to PanSTARRS PS1 partners.
  - Closest to ODI's data structure and instrument.
  - Carries CFHT Megacam knowledge / legacy.

  - Interface on fits-file level.
  - ODI & PanSTARRS have same data format (per agreement).

  - Further synergy benefits. Share existing code. Concentrate on recipes.

- Also look at DES pipeline. Contact established (through Kathy Rhode, IU).

- Combine PanSTARRS modules & DES architecture?

Tier 1-3 Implementation continued

- Run in Teragrid environment (similar to DEC pipeline)!
  - Data storage & CPU time provided by Indiana University.

- Operate Tier 1 from WIYN @ IU as service for observers.
  - Internet 2.0 connection essential. Link to Kitt Peak is bottleneck!

- Operate Tier 2+3 pipeline at Indiana University by users.
  - Details to be determined.

- Operate ODI in Queue mode.
  - Data calibration plan tightly integrated into queue operations.
  - Hire two scientists for pipeline & queue.

ODI @ AAS 2009 Summer Meeting

- Meeting in a Meeting requested for ODI:
  - 3 x 3h sessions.

- Engage community for:
  - Update on instrument status.
  - Operational modes, pipelines, queue.
  - Develop science cases & collaborations.
  - Include community into Yale 90-night survey (TSIP funding!)

- Develop a “big picture” of wide-field imaging science:
  - ODI, DEC, LSST, PanSTARRS.

-